

The opinion in support of the decision being entered today was not written for publication and is not binding precedent of the Board.

Paper No. 14

UNITED STATES PATENT AND TRADEMARK OFFICE

BEFORE THE BOARD OF PATENT APPEALS
AND INTERFERENCES

Ex parte MASAMICHI AZUMA, CARLOS A. PAZ DE ARAUJO,
MICHAEL C. SCOTT and TOSHIYUKI UEDA

Appeal No. 1998-0129
Application No. 08/438,062

ON BRIEF

Before HAIRSTON, JERRY SMITH, and LEVY, Administrative Patent Judges.

LEVY, Administrative Patent Judge.

DECISION ON APPEAL

This is a decision on appeal under 35 U.S.C. § 134 from the examiner's final rejection of claims 1, 2, 4-7, and 25-27¹.

¹ The examiner's answer (page 2) states that "[c]laim 3 is objected to as being dependent upon a rejected base claim, but would be allowable if written in independent form" Appellants assert (reply brief, page 2) that "the Examiner's present indication that claim 3 is allowable if rewritten in independent form constitutes a new grounds of rejection," and that "Appellants' attorney respectfully requests the Board to confirm or deny

(continued...)

BACKGROUND

The appellants' invention relates to a thin film capacitor including a BST film as a dielectric, on a gallium arsenide substrate. An understanding of the invention can be derived from a reading of exemplary claim 1, which is reproduced as follows:

1. A high capacitance thin film capacitor device comprising:

a gallium arsenide substrate;

a barrier layer formed on said substrate;

a stress reduction layer on said barrier layer; and

a capacitor on said stress reduction layer, said capacitor comprising a first electrode, a second electrode, and a barium strontium titanate dielectric material between said electrodes.

The prior art references of record relied upon by the examiner in rejecting the appealed claims are:

¹(...continued)
whether claim 3 is rejected on new grounds . . ." In light of the examiner's withdrawal of the grounds of rejection of claim 3, there is no new ground of rejection of claim 3, and claim 3 is no longer before us for decision on appeal. In addition, as brought to our attention by both the examiner (answer, page 2) and appellants (reply brief, pages 2 and 3), claim 4 inadvertently depends from itself, instead of from claim 1. We consider this a formality that can be addressed subsequent to this appeal. For purposes of this appeal, we shall consider claim 4 to depend from claim 1.

Miller et al. (Miller) 5,046,043 Sep. 3. 1991

Koyama et al. (Koyama) "A STACKED CAPACITOR WITH $(\text{Ba}_x\text{Sr}_{1-x})\text{TiO}_3$ FOR 256M DRAM," IEDM, Dec. 1991, pp. 32.1.1-32.1.4.

McMillan et al. (McMillan) "DEPOSITION OF $\text{Ba}_{1-x}\text{Sr}_x\text{TiO}_3$ AND SrTiO_3 VIA LIQUID SOURCE CVD (LSCVD) FOR ULSI DRAMS," ISIF Conference, March, 1992.

Claims 1, 2, 4-7 and 25-27 stand rejected under 35 U.S.C. § 103 as being unpatentable over Miller in view of McMillan.

Claims 1, 2, 4-7 and 25-27 stand rejected under 35 U.S.C. § 103 as being unpatentable over Miller in view of Koyama.

Rather than reiterate the conflicting viewpoints advanced by the examiner and the appellants regarding the above-noted rejections, we make reference to the examiner's answer (Paper No. 11, mailed April 7, 1997) for the examiner's complete reasoning in support of the rejections, and to the appellants' brief (Paper No. 10, filed February 24, 1997) and reply brief (Paper No. 12, filed June 9, 1997) for the appellants' arguments thereagainst. Only those arguments actually made by the appellants have been considered in this decision. Arguments which the appellants could have made but chose not

to make in the briefs have not been considered. See 37 CFR 1.192(a).

OPINION

In reaching our decision in this appeal, we have carefully considered the subject matter on appeal, the rejections advanced by the examiner, and the evidence of obviousness relied upon by the examiner as support for the rejections. We have, likewise, reviewed and taken into consideration, in reaching our decision, the appellants' arguments set forth in the briefs along with the examiner's rationale in support of the rejections and arguments in rebuttal set forth in the examiner's answer. As a consequence of our review, we make the determinations which follow.

In rejecting claims under 35 U.S.C. § 103, it is incumbent upon the examiner to establish a factual basis to support the legal conclusion of obviousness. See In re Fine, 837 F.2d 1071, 1073, 5 USPQ2d 1596, 1598 (Fed. Cir. 1988). In so doing, the examiner is expected to make the factual

determinations set forth in Graham v. John Deere Co., 383 U.S. 1, 17, 148 USPQ 459, 467 (1966), and to provide a reason why one having ordinary skill in the pertinent art would have been led to modify the prior art or to combine prior art references to arrive at the claimed invention. Such reason must stem from some teaching, suggestion or implication in the prior art as a whole or knowledge generally available to one having ordinary skill in the art. Uniroyal, Inc. v. Rudkin-Wiley Corp., 837 F.2d 1044, 1051, 5 USPQ2d 1434, 1438 (Fed. Cir.), cert. denied, 488 U.S. 825 (1988); Ashland Oil, Inc. v. Delta Resins & Refractories, Inc., 776 F.2d 281, 293, 227 USPQ 657, 664 (Fed. Cir. 1985), cert. denied, 475 U.S. 1017 (1986); ACS Hosp. Sys., Inc. v. Montefiore Hosp., 732 F.2d 1572, 1577, 221 USPQ 929, 933 (Fed. Cir. 1984). These showings by the examiner are an essential part of complying with the burden of presenting a prima facie case of obviousness. Note In re Oetiker, 977 F.2d 1443, 1445, 24 USPQ2d 1443, 1444 (Fed. Cir. 1992). If that burden is met, the burden then shifts to the applicant to overcome the prima facie case with argument and/or evidence. Obviousness is then determined on the basis of the evidence as a whole. See id.;

In re Hedges, 783 F.2d 1038, 1039, 228 USPQ 685, 686 (Fed. Cir. 1986); In re Piasecki, 745 F.2d 1468, 1472, 223 USPQ 785, 788 (Fed. Cir. 1984); and In re Rinehart, 531 F.2d 1048, 1052, 189 USPQ 143, 147 (CCPA 1976).

We consider first the rejection of claim 1 based on the teachings of Miller in view of each of McMillan or Koyama. The examiner's position (answer, pages 5 and 6) is that Miller discloses the invention substantially as claimed, including a high dielectric constant PZT material 30; but does not disclose the high dielectric constant material 30 of the capacitor being BST. To overcome this deficiency in Miller, the examiner turns to each of McMillan or Koyama. The examiner asserts (answer, page 6) that McMillan discloses replacing PZT layers in capacitors with BST to take advantage of the high dielectric constant of BST, as well as to prevent significant decrease of the dielectric constant at high frequencies. In addition, the examiner asserts (answer, page 7) that Koyama teaches the use of both PZT and BST in capacitors, for their high dielectric constants. The examiner further notes that Koyama teaches (id.), that BST is preferred

over PZT because BST has stable electrical characteristics and has no fatigue problems.

Appellants note (brief, page 6) that the ferroelectric layer 30 of Miller is made of PZT or PLZT, and that Miller is silent as to any express or implied problems with respect to PZT ferroelectrics. Appellants assert that Miller does not teach the use of a BST dielectric, and that (brief, page 7) the references relied upon by the examiner are completely devoid of any reference to gallium arsenide substrates.

From our review of the references, we find that Miller teaches (col. 3, lines 25-38) a ferroelectric capacitor designed for fabrication into MOS structure on a semiconductor substrate. Specifically, Miller teaches (col. 3, lines 37-39) that the capacitor is fabricated on a "semiconductor substrate 12, which is typically silicon or gallium arsenide." From these teachings of Miller, we are not in agreement with appellants' statement (brief, page 13) that Miller mentions the use of gallium arsenide as a substrate "only as an afterthought." We consider the statement in Miller (col. 3, lines 37-39) that the semiconductor layer is "typically" silicon or gallium arsenide to clearly teach the use of a

gallium arsenide substrate in the formulation of a capacitor having a PZT dielectric layer between the electrodes.

Appellants assert (brief, page 9) that Miller cannot be combined with McMillan or Koyama because there is no suggestion or motivation in the prior art to combine the references. We find that McMillan (page 2) discloses that "[a]s indicated in Figure 1, it appears, however, that barium strontium titanate [BST] . . . could overcome many of these problems and easily satisfy the requirements for the next generation of ULSI DRAM'S. Rather high dielectric constant values have been reported . . . " and that (page 8) "[w]e have shown that very good . . . barium strontium titanate [BST] can be deposited via LSCVD. We have now achieved sufficient success with this method of deposition" From these teachings of McMillan, we are in agreement with the examiner (answer, page 6) that McMillan suggests that one of ordinary skill in the art would have been taught to replace the high dielectric PZT in the capacitor of Miller with BST in order to overcome many of the problems associated with the use of PZT.

From our review of Koyama, we find that Koyama discloses
(32.1.1, col. 1) that

With the recent increase in the integration density of DRAMs, a large charge storage density has been required, so several high dielectric constant materials, i.e., PZT[1,2], PLZT[3], BaTiO₃[4], SrTiO₃[5] and (Ba_xSr_{1-x})TiO₃ [6] have been proposed for DRAM capacitors. A DRAM capacitor film needs a high dielectric constant and low leakage current and high reliability for voltage stress. We chose (Ba_xSr_{1-x})TiO₃ among them due to the following reasons; (1) The composition control is easy, so the electrical characteristics should be stable. (2) The phase is paraelectric over the device operating temperature range, so the film should have no fatigue problems.
. . .

This paper describes the fabrication and electrical properties of the stacked capacitor realized by utilizing
a high-dielectric-constant material (Ba_{0.5}Sr_{0.5})TiO₃ for the first time. ([] original).

We find that Koyama, having considered several high dielectric materials including, inter alia, PZT, PLZT, and BST, chose BST for the reasons quoted, supra. From these teachings of Koyama, we are in agreement with the examiner (answer, page 7) that Koyama would have suggested replacing the PZT or PLZT layer of Miller with BST to exhibit stable electrical characteristics and to avoid the problem of fatigue.

We therefore, conclude that the examiner has established a prima facie case of obviousness of the invention. As the examiner has met the burden of establishing a prima facie case, the burden now shifts to the appellants to overcome the prima facie case with argument and/or evidence. Obviousness will then be determined on the basis of the evidence as a whole.

Appellants have submitted three declarations² under 37 CFR § 1.132. The first is the Declaration of Masamichi Azuma (Azuma Declaration)³. The second is the Declaration of Larry D. McMillan (McMillan Declaration). The McMillan Declaration is directed to the issue of capacitance stability at high frequencies, which is set forth in claims 25-27. Accordingly, our evaluation of the McMillan Declaration will be discussed in our review of claims 25-27, appearing later in this

² All three Declarations were filed on July 22, 1996 (Paper No. 6).

³ Although of record in the application, the Azuma Declaration has not been referred to by either appellants or the examiner. We note that the Azuma Declaration is only directed to the issue of whether two references cited in the parent application (which are not applied against the claims of this application) should have been included in an IDS. Accordingly, we will not further address the Azuma Declaration.

decision. The third is the Declaration of Carlos A. Paz de Araujo (Araujo Declaration).

Turning to the Araujo Declaration, appellants assert (brief, page 8) that "Symetrix and Matsushita have received the Okouchi award for the presently claimed devices." We find that Exhibit A of the Araujo Declaration states that "MEC received the Okouchi Award . . . for the "GaAs MMIC Technology" derived from the MEC/Symetrix collaboration efforts. . . ." It does not specifically state that the Award was to "Symmetrix and Matsushita" as asserted by appellants. Exhibit A (page 2) states that the Award was "for GaAs MMICs integrating BST capacitors." We note, however, that the Okouchi award was not for appellants' capacitor, per se, but rather for the GaAs MMIC technology integrating appellants' capacitor into a mobile phone. We take note of appellants' statement (brief, page 8) that "[t]he Okouchi award that is shown in Exhibit A attached to the Declaration is perceived by many persons to be Japan's most prestigious electronics industry award for innovation and achievement." Appellants further assert (id.), as evidence of "huge commercial success," that as of the time of the Declaration, the claimed

devices were installed on sixty-nine percent of the digital mobile phones being sold in Japan and that (reply brief, page 12) "[t]oday that number is closer to 100%."

The examiner asserts (answer, page 10) that the evidence of commercial success is not commensurate with the scope of the claims, and that the evidence of commercial success relates to BST GaAs MMIC chips installed in mobile phones, not to the claimed invention.

We find that page 1 of Exhibit C of the Araujo Declaration states that

construction in MMIC is indispensable to realize further miniaturization. If construction in MMIC is realized, it will enable:

- C Downsizing to 1/50
- C Cost reduction to 1/40
- C Light weight

We note that integration of the capacitors into MMIC is not set forth in any of appellants' claims before us on appeal.

We do, however, note that Exhibit D of the Araujo Declaration states that "[t]he key to the chip, though, comes from Symetrix. . . ." We further take note of the fact that the Araujo Declaration (page 5, paragraph 16) states that the "Nikkei Shinbun, Japan's largest newspaper, gave its chip

product of the year award to Matsushita, but that Symetrix Corporation participated in the development of the chip."

We find that the Araujo Declaration (page 2, paragraph 5) states that

The claims of the present application are directed to the method of making the very same chips that received the Okouchi Award shown in Exhibit A. The claimed method imparts to the devices the reduced power dissipation and downsizing that justified the award. Features of the claims that impart these improvements include the specific sequence of layering steps followed by the deposition of a liquid precursor and a carefully controlled anneal.

We note that the method of manufacturing the capacitor incorporating BST is not claimed. Appellants do not claim a specific sequence of layering steps, nor a carefully controlled anneal process. Appellants assert (reply brief, page 11) that the claimed method referred to in the Araujo Declaration included claim 8 of the related 08/214,401 application. Our review of the claim language provided by appellants does not reveal any language regarding a carefully controlled anneal process as stated in the Araujo Declaration. From the evidence before us, manufacturing process aspects of the claimed method, other than the steps of claim 8, may have

contributed to the formulation of the capacitor and its integration into MMICs, resulting in the Okouchi Award.

Appellants assert (brief, pages 10-11) that

The indicated obviousness rejections cannot be sustained because none of the references address the problem that Appellants have overcome.

Appellants take the position (reply brief, pages 9 and 10) that

The Examiner indicates on page 10 of the Answer at lines 5-7 that the Examiner's reasons for combining prior art references need not be the same reasons why Appellants have developed the claimed invention and, besides, the prior art references provide the same reasons as Appellants. (emphasis original).

The Examiner cites no law in support of his position. Appellants have already addressed the issue that the references do not teach the use of BST on GaAs to obtain stable high frequency capacitance. Appellants now address the Examiner's premise that the Examiner may combine the references for other reasons apart from the reasons why Appellants have developed the invention. Consider the opinion of the Court of Appeals For the Federal Circuit on this issue:

The Commissioner argues that if it is obvious to combine the teachings of prior art references for any purpose, they may be combined in order to defeat patentability of the applicant's admittedly new structure. The PTO states that 'a claimed invention may be unpatentable if it

would have been obvious for reasons suggested by the prior art, even though those reasons may be different from the reasons relied upon by the inventor and may result in a different advantage.'

The PTO position is that it is irrelevant that Wright's structure was for a particular purpose, and has properties, that are neither obtainable from the prior art structures, nor suggested in the prior art. In this lies the PTO's error.

In re Wright, 6 USPQ2d 1959, 1961 (Fed. Cir. 1988). The Examiner has made a fundamental error alleging that references may be combined for any reason, even if that reason is irrelevant to the purpose of Appellants' invention because Appellants have demonstrated that the BST on GaAs combination has properties that are neither obtainable nor suggested in the Miller et al, McMillan et al, or Koyama et al references. See also, *In re Albrecht, et al.*, 185 USPQ 585, 588-590 (CCPA 1975). *Wright* further states that:

We repeat the mandate of 35 U.S.C. § 103: it is the invention as a whole that must be considered in obviousness determinations. The invention as a whole embraces the structure, its properties, and the problem it solves.... Thus the question is whether what the inventor did would have been obvious to one skilled in the art attempting to solve the problem upon which the inventor was working.

In re Wright, Supra, p. 1961. Here, the cited references do not address the problem that the inventors herein were working on.

The arguments are not persuasive that any error in the examiner's determination regarding the obviousness of the claimed subject matter has occurred. As long as some motivation or suggestion to combine the references is provided by the prior art taken as a whole, the law does not require that the references be combined for the reasons contemplated by the inventor. See In re Dillon, 919 F.2d 688, 693, 16 USPQ2d 1897, 1901 (Fed. Cir. 1990)(en banc), cert. denied, 500 U.S. 904 (1991) and In re Beattie, 974 F.2d 1309, 1312, 24 USPQ2d 1040, 1042 (Fed. Cir. 1992).

Upon reevaluating anew the evidence of obviousness presented by the examiner along with the evidence of nonobviousness relied upon by appellants, we conclude that the evidence of obviousness substantially outweighs the evidence of nonobviousness for the reasons outlined above. Accordingly, the rejections of claim 1 under 35 U.S.C. § 103 as unpatentable over Miller, in view of each of Koyama or McMillan are affirmed. As claims 2 and 5-7 stand or fall with claim 1, the rejections of claims 2 and 5-7 under 35 U.S.C. § 103 as unpatentable over Miller, in view of each of Koyama or McMillan are also affirmed.

Turning now to the rejection of claim 4, we find that the claim recites that the barium strontium titanate dielectric material has the specific formula $\text{Ba}_{0.7}\text{Sr}_{0.3}\text{TiO}_3$. The examiner's position (answer, page 6) is that McMillan teaches the claimed formula and that it would have been obvious to have replaced the PZT layer of Miller with the $\text{Ba}_{0.7}\text{Sr}_{0.3}\text{TiO}_3$ of McMillan to provide a high dielectric constant. The examiner also takes the position (answer, pages 7 and 8) that Koyama shows the general formula $\text{Ba}_x\text{Sr}_{1-x}\text{TiO}_3$, and that the specific formula $\text{Ba}_{0.7}\text{Sr}_{0.3}\text{TiO}_3$ would have been a discovery of an optimum result of a result effective variable, involving only routine skill in the art.

Appellants' assert (brief, page 10) that "[s]ome BST formulations are both ferroelectric and high dielectric materials, but the preferred formulation $\text{Ba}_{0.7}\text{Sr}_{0.3}\text{TiO}_3$, is not ferromagnetic at normal integrated circuit operating temperatures." Appellants further assert (brief, page 14) that [t]his is quite different from the Miller et al. device, which teaches a PZT or PLZT *ferroelectric* layer 30."

We find that Koyama does not teach $\text{Ba}_{0.7}\text{Sr}_{0.3}\text{TiO}_3$ as claimed, but rather teaches $\text{Ba}_{0.5}\text{Sr}_{0.5}\text{TiO}_3$. In view of appellants'

statement that $\text{Ba}_{0.7}\text{Sr}_{0.3}\text{TiO}_3$ is non-ferromagnetic at normal integrated circuit operating temperatures, we conclude that although the formulation of BST is a result effective variable, and the prior art suggests a capacitor having a BST layer on a gallium arsenide substrate and a barrier diffusion layer, that one of ordinary skill in the art with the disclosures of Miller and Koyama before him/her would not have been taught to have provided non-ferromagnetic formulation $\text{Ba}_{0.7}\text{Sr}_{0.3}\text{TiO}_3$. In considering what the teachings of the prior art references as a whole would have suggested to one of ordinary skill in the art, we find no suggestion that one of ordinary skill in the art would have been motivated to have looked to a different formulation of BST than the formulation disclosed by Koyama. Accordingly, we find that the examiner has failed to establish a prima facie case of obviousness of claim 4 under 35 U.S.C. § 103 as unpatentable over Miller in view of Koyama. Accordingly, the rejection of claim 4 under 35 U.S.C. § 103 as unpatentable over Miller in view of Koyama is reversed.

We reach a different conclusion, however, as to what the teachings of Miller and McMillan, considered as a whole, would

have suggested to one of ordinary skill in the art. As acknowledged by appellants (brief, page 7) "McMillan et al. shows $\text{Ba}_{0.7}\text{Sr}_{0.3}\text{TiO}_3$." We find that McMillan specifically teaches the use of $\text{Ba}_{0.7}\text{Sr}_{0.3}\text{TiO}_3$ as a high dielectric material in a capacitor and teaches the use of BST to overcome many of the problems associated with the use of high dielectric constant PZT. From the teachings of Miller and McMillan of providing a capacitor having $\text{Ba}_{0.7}\text{Sr}_{0.3}\text{TiO}_3$ on a gallium arsenide layer and a diffusion barrier layer, we find that one of ordinary skill in the art would have been motivated to have utilized $\text{Ba}_{0.7}\text{Sr}_{0.3}\text{TiO}_3$ in a high dielectric capacitor to overcome problems associated with PZT, as recognized by McMillan. We find that in view of McMillan's specific disclosure (Figure 2) of both ferroelectric BST and non-ferroelectric BST, i.e., $\text{Ba}_{0.7}\text{Sr}_{0.3}\text{TiO}_3$, as a dielectric material, that the resultant structure from the combined teachings of the prior art references of Miller and McMillan would have been a capacitor as taught by McMillan on a gallium arsenide substrate including a diffusion barrier layer, and a BST layer that would have been either ferroelectric or non-ferroelectric ($\text{Ba}_{0.7}\text{Sr}_{0.3}\text{TiO}_3$). We therefore, conclude that the

examiner has established a prima facie case of obviousness of the invention of claim 4 under 35 U.S.C. § 103 as unpatentable over Miller in view of McMillan. As the examiner has met the burden of establishing a prima facie case, the burden now shifts to the appellants to overcome the prima facie case with argument and/or evidence. Obviousness will then be determined on the basis of the evidence as a whole.

We make reference to our earlier findings with regard to the Araujo Declaration. In addition, the Araujo Declaration (page 2, paragraph 6) states that "Exhibit B to this Declaration includes photostatic copies of supportive information that Matsushita supplied to the Okouchi Foundation prior to receiving the award." We take note of the fact that Exhibit B of the Araujo Declaration specifically lists that the BST is formulated as $\text{Ba}_{0.7}\text{Sr}_{0.3}\text{TiO}_3$.

Upon reevaluating anew the evidence of obviousness presented by the examiner along with the evidence of nonobviousness relied upon by appellants, we conclude that the evidence of obviousness substantially outweighs the evidence of nonobviousness for the reasons outlined above.

Accordingly, we will affirm the rejection of claim 4 under 35 U.S.C. § 103 as unpatentable over Miller in view of McMillan.

Turning now to the rejection of claims 25-27, we note that claim 25 recites that the capacitor exhibits an essentially stable capacitance with no roll-off at frequencies ranging from 0.1 GHz up to at least 0.2 GHz. Claim 26, which depends from claim 25, recites that the stable capacitance ranges from 0.1 GHz up to at least 1 GHz. Claim 27, which depends from claim 25, recites that the stable capacitance ranges from 0.1 GHz up to at least 10 GHz.

The examiner takes the position (answer, pages 10 and 11) that "structures of prior art combination being the same as those of the claimed invention, stable capacitance at the high frequency ranges would inherently and expectedly result from such structures."

Appellants state (reply brief, page 3) that the examiner (answer, page 6) has cited McMillan as teaching that the dielectric constant of BST does not decrease at high frequencies. Appellants contend (reply brief, page 3) that McMillan teaches exactly the opposite. Appellants provide the

following quote from McMillan (pages 1 and 2) in support of their position

There appears, however, to be a general (and understandable) reluctance in the IC industry to move away from the well understood and well characterized silicon dioxide (or silicon nitride) dielectric system. There are a number of reasons for this. Choosing the right material for ULSI DRAM's is not an easy task. Many of the new (proposed) high dielectric constant materials have very complex, multi-component structures that are difficult to synthesize and contain elements that are normally considered to be contaminants or hazardous in a processing area. Some of the well known high dielectric constant materials (such as lead zirconate titanate) exhibit ferroelectric properties such that the dielectric constant decreases significantly at high frequencies. In general, most of these new materials are difficult to produce consistently with existing thin film deposition equipment.

Appellants go on to state (reply brief, page 4) that "[t]he above-quoted passage from McMillan et al. merely states that known high dielectric materials such as lead zirconate titanate or PZT, exhibit capacitance rolloff at high frequencies. . . . The quoted passage (and the entire McMillan et al. reference) says absolutely nothing about the high frequency performance of BST materials." We find that further reading of McMillan discloses

(page 2) that

As indicated in Figure 1, it appears, however, that barium strontium titanate . . . could overcome many of these problems and easily satisfy the requirements for the next generation of ULSI DRAM'S. Rather high dielectric constant values have been reported . . . and several companies have already begun evaluation of various thin-film deposition techniques for prototype production.

and that (page 7)

We have shown that very good . . . barium strontium titanate films can be deposited via LSCVD. We have now achieved sufficient success with this method of deposition for complex films on four inch wafers to warrant construction of a new LSCVD machine for six inch wafers.

From these teachings we find that McMillan has recognized the problem of significant roll-off of dielectric constant at high frequencies when using well-known high dielectric material such as PZT. In addition, McMillan's solution was to replace PZT with BST to overcome many of the problems associated with PZT. Moreover, McMillan teaches (Figure 5) that in typical processing parameters for BST, the films were annealed at temperatures greater than 550EC.

Appellants note (reply brief, page 6) that the examiner (answer, page 10) has relied upon Koyama for a teaching of

selecting BST over PZT in order to provide stable electrical characteristics and to prevent fatigue. Appellants assert (reply brief, pages 6 and 7) that the concepts of stability and fatigue referred to by Koyama (page 32.1.1, col.1) have "nothing to do with capacitance stability at high frequencies."

From our review of Koyama, we find that Koyama does not make specific reference to capacitance stability at high frequencies. However, we find that Koyama, having considered several high dielectric materials including, inter alia, PZT, PLZT, and BST, chose BST because of BSTs stable electrical characteristics, and to prevent fatigue. From these teachings of Koyama, we find that Koyama would have suggested replacing the PZT or PLZT layer of Miller with BST. As the teachings of Miller and Koyama as a whole would have suggested replacing PZT with BST, we are in agreement with the examiner (answer, page 10) that the capacitor would have inherently exhibited stable capacitance at high frequencies.

Accordingly, we are in agreement with the examiner that stable capacitance at the claimed high frequency ranges would have expectedly resulted from modification of Miller in view

of each of Koyama and McMillan. See In re Ludtke, 441 F.2d 660, 664, 169 USPQ 563, 566 (CCPA 1971).

We, therefore, conclude that the examiner has established a prima facie case of obviousness of the invention. As the examiner has met the burden of establishing a prima facie case, the burden now shifts to the appellants to overcome the prima facie case with argument and/or evidence. Obviousness will then be determined on the basis of the evidence as a whole.

We make reference to our earlier findings with regard to the Araujo Declaration. Additionally, as stated in the Araujo Declaration (page 3, paragraph 8), "Item 2 on page 1 of Exhibit B shows a direct comparison of laboratory results indicating that the dielectric constant (and corresponding capacitance) of PZT thin films falls off below 100 MHZ, but that the capacitance of BST thin films can be stabilized out to about 10 GHZ." We are cognizant of the stable capacitance achieved by utilization of BST, and we find that the teachings of Miller considered with each of both Koyama or McMillan would have suggested the use of BST as a high dielectric material as advanced by the examiner.

Turning to the McMillan Declaration, appellants assert (brief, page 11) that the McMillan Declaration (page 3, paragraph 7) discusses a 1996 ISIF article showing that researchers in 1996 determined that BST on silicon substrate devices exhibited rolloff at frequencies of about 0.5-0.7 GHz, and that in contrast, appellants have disclosed and claimed a BST on gallium arsenide device. Appellants further assert (brief, page 11) that the claimed BST on a gallium arsenide device is specially annealed to make it capable of providing a stable capacitance that is an order of magnitude better than that reported by the ISIF researchers in 1996. The examiner states (answer, page 10) that "there is [sic] no unexpected results with respect to the claimed invention. Prior art references teach the expected result of using BST to replace PZT in capacitors to provide the capacitor devices with stable capacitance and electrical characteristics, and with high dielectric constants; and to prevent the capacitor devices from being fatigue [sic]." We note that the McMillan Declaration (page 2, paragraph 4), states that "Exhibit A provides a comparison between theoretical and experimental capacitances at high frequencies for PZT materials" and that

(page 3, paragraph 7) "Exhibit B shows that those skilled in the art are only now coming to realize that BST materials fundamentally have a better high frequency capacitance than do PZT materials."

We find that Exhibit B of the McMillan Declaration, entitled High Frequency Electrical Characteristics of BST Capacitors, (ISIF 1996), by Jammy et al. (Jammy) characterizes the dielectric properties of the same formulation of BST as found in the capacitor of Koyama. According to Jammy, the BST capacitor exhibited roll-off near 1 GHz. According to the McMillan Declaration (page 3, paragraph 7), the roll-off appears at

0.5-0.7 GHz. However, we find that the Jammy BST capacitor experienced roll-off because the BST capacitor of Jammy does not utilize a gallium arsenide substrate and a diffusion barrier layer. The McMillan Declaration states (page 3, paragraph 8) that the problem of capacitance roll-off is "overcome by using a gallium arsenide substrate and a diffusion barrier layer before depositing the first electrode." We note that Miller teaches (col. 3, lines 40-41) the use of a gallium arsenide substrate 12 and (col. 4, lines

1-10) a diffusion barrier layer 16 along with high dielectric constant material (PZT or PLZT). In addition, Koyama recognized (page 32.1.1, col. 1) the need for high dielectric constant, low leakage current and reliability for voltage stress.

Appellants assert (brief, page 14) that "[i]t is irrelevant that the Examiner argues the substitution of the BST for the Miller et al. PZT would inherently have this high capacitance response, because the Examiner has not shown that those skilled in the art knew, at the time of the invention, that the BST could provide the claimed high frequency capacitance." Appellants further assert (reply brief, pages 5 and 6) that neither McMillan nor Koyama recognized that BST may be substituted for PZT to obtain stable capacitance at high frequencies.

As we stated, supra, as long as some motivation or suggestion to combine the references is provided by the prior art taken as a whole, the law does not require that the references be combined for the reasons contemplated by the inventor. See In re Dillon, 919 F.2d at 693, 16 USPQ2d at 1901, and In re Beattie, 974 F.2d at 1312, 24 USPQ2d at 1042.

Upon reevaluating anew the evidence of obviousness presented by the examiner along with the evidence of nonobviousness relied upon by appellants, we conclude that the evidence of obviousness substantially outweighs the evidence of nonobviousness for the reasons outlined above. Accordingly, the rejection of claims 25-27 under 35 U.S.C. § 103 as unpatentable over Miller in view of each of Koyama or McMillan is affirmed.

CONCLUSION

To summarize, the decision of the examiner to reject claims 1, 2, 4-7 and 25-27 under 35 U.S.C. § 103 as obvious over Miller in view of McMillan is affirmed. The decision of the examiner to reject claims 1, 2, 5-7 and 25-27 under 35 U.S.C. § 103 over Miller in view of Koyama is affirmed. The decision of the examiner to reject claim 4 under 35 U.S.C. § 103 over Miller in view of Koyama is reversed.

No time period for taking any subsequent action in connection with this appeal may be extended under 37 CFR § 1.136 (a).

AFFIRMED

KENNETH W. HAIRSTON)	
Administrative Patent Judge)	
)	
)	
)	
)	BOARD OF PATENT
JERRY SMITH)	APPEALS
Administrative Patent Judge)	AND
)	INTERFERENCES
)	
)	
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STUART S. LEVY)	
Administrative Patent Judge)	

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